# METHOD AND APPARATUS FOR DYNAMIC CHANNEL ALLOCATION IN TDD CDMA COMMUNICATION SYSTEM

## Field of the Invention

The present invention relates generally to a communication method and apparatus in mobile communication systems, and more particularly, to a dynamic channel allocation (DCA) method and apparatus for use in TDD CDMA communication system.

## Background of the Invention

Compared with other mobile communication systems, such as FDMA communication system, TDMA communication system and so on, CDMA is a more advanced mobile communication system, with higher capacity and spectrum efficiency. There are two operation modes in CDMA system, FDD and TDD. That is, there are two communication systems in CDMA, FDD CDMA and TDD CDMA. During the early period, FDD CDMA communication system won wide applications and developments, while TDD CDMA communication system was only introduced as a complement of FDD CDMA at that time. With the development of CDMA communication systems, TDD CDMA is drawing more and more attention, and the related researches are carried out more broadly and deeply. Under this background, China put forward a TDD CDMA communication system, TD-SCDMA, which has been adopted by ITU as one of the three mainstream CDMA communication systems to implement 3G mobile communications. The Chinese

government provides great support for TD-SCDMA, and allocated 155MHz spectrum for TD-SDCMA. Thus, TDD CDMA communication system is recognized as very promising in the future.

In TDD CDMA communication system, each RNS (Radio Network System) is composed of one RNC and at least one base station, wherein the base station is responsible for communicating with UEs via wireless medium, and a main function of RNC is to allocate communication radio resource for the base station and UEs and manage the resource. For simplicity, the base station and RNC in RNS are generally called as base station together.

In TDD CDMA communication system, power control is generally applied in uplink, thus, signals sent from all UEs allocated in the same uplink timeslot will reach the receiver of the base station with approximately equal power. Accordingly, the situation that strong signal suppresses weak signal in the base station almost does not exist, that means the far-near effect won't happen in uplink. Furthermore, in TD-SCDMA communication system, synchronization control is applied for uplink, so signals sent from all UEs allocated in the same uplink timeslot will reach the receiver of the base station almost simultaneously, which reduces the multi-access in uplink to the greatest extent.

But in downlink, a mobile terminal in a downlink timeslot, will receive signals sent by the base station to it, and signals sent by the base station to other UEs allocated in the downlink timeslot as well. The distance between each UE allocated in the same downlink timeslot and the base station is different, so, the base station has to transmit signals to UEs with different distance at different

transmission power, the farther the distance, the higher the transmission power, so as to ensure that signals received by each UE can satisfy a predefined QoS requirement. Accordingly, when a close UE receives signals sent by the base station to a remote UE in the same downlink timeslot, signals sent to the remote UE at higher transmission power will produce interference to signals sent to the close UE at lower transmission power and thus this affects signal reception of the close UE, which is the far-near effect often occurring in downlink. How to settle the far-near effect will have a significant influence upon the downlink communication performance of TDD CDMA communication system.

A detailed description will be given below to clarify the far-near effect in downlink, in conjunction with Fig.1.

As Fig.1 shows, this cell includes a base station, UE0 and UE1, wherein UE0 is close to the base station while UE1 is far away from the base station. Assume UE0 and UE1 are allocated in the same downlink timeslot, the base station transmits signal S0 to UE0 and signal S1 to UE1 in the downlink timeslot. Because UE0 and UE1 have different distance to the base station, the base station should transmit signal S1 at a higher transmission power P1 and transmit signal S0 at a lower transmission power P0, so that signal S0 received by UE0 and signal S1 received by UE1 can both satisfy the QoS requirement.

The attenuation of the signal in a fading channel is proportional to the nth order of the transmission distance, and n generally is a value more than 3. Assume n=3, if the distance between UE0 and the base station is half of that between UE1 and the base station, in order that the power for signal S0 to reach

UE0 and that for signal S1 to reach UE1 can both meet the QoS requirement, the transmission power P1 at which the base station transmits signal S1 should be 8 times more than the transmission power P0 at which the base station transmits signal S0.

That is, when the base station is transmitting S0 and S1 in the same downlink timeslot respectively at P0 and P1, UE0 can receive S0 sent by the base station to it, and S1 sent by the base station to UE1 as well, and the power of S0 reaching UE0 is only 1/8 of that of S1 reaching UE0. If the transmission angle between S1 and S0 is so large that S1 and S0 are transmitted with beams in different directions, then S1 reaching UE0 will not produce interference to UE0's receiving S0. Otherwise, if the base station transmits S0 and S1 with beams in the same direction, S1 (the strong signal) will become interfering signal for S0 (the weak signal).

In Fig.1, if there exist several interfering UEs like UE1 who produces interfering signal to UE0, UE0's communication performance will be deteriorated seriously.

Summary of the Invention

An object of the present invention is to provide a dynamic channel allocation (DCA) method and apparatus for use in TDD CDMA communication system, capable of reducing or canceling communication interferences brought by the far-near effect in the downlink of TDD CDMA communication system, and thus improving the downlink communication performance of TDD CDMA communication system.

A DCA method for use in TDD CDMA communication system is proposed in the present invention, to be performed by a UE, comprising: in a downlink timeslot, receiving the signals transmitted by a network system to each UE allocated in the downlink timeslot; estimating the strength of each interfering signal introduced by the signals transmitted to other UEs to the signal transmitted to the UE in the received signals; transmitting the information about each interfering UE whose interfering signal strength exceeds a predefined value, to the network system via an uplink.

A DCA method for use in TDD CDMA communication system is proposed in the present invention, to be performed by a network system, comprising: receiving from a UE the information about each interfering UE producing interfering signal to the UE; allocating network resource to the interfered UE according to the information about the interfering UE; reporting the allocated network resource to the interfered UE so that the interfered UE can receive signals transmitted from the network system by utilizing the allocated network resource.

Brief Description of the Drawings

Fig.1 is a schematic diagram illustrating the downlink far-near effect in conventional TDD CDMA communication system;

Fig.2 is a schematic diagram illustrating the method for canceling downlink far-near effect in TDD CDMA communication system in accordance with the present invention;

Fig.3 is a flow chart illustrating the DCA method for use in TDD CDMA communication system in accordance with the present invention;

Fig.4 displays the structure of the DCA apparatus in TDD CDMA communication system in the embodiment of the present invention;

Detailed Description of the Invention

The main idea of the present invention is to allocate each UE in different downlink timeslot, to avoid the interference caused by the far-near effect when UEs in the same downlink timeslot and with different distance to the base station are receiving signals transmitted by the base station with beams in the same direction.

Specifically, when a UE is receiving signals in a downlink timeslot, if it is interfered by the signals transmitted to other UEs in the same timeslot from the base station, the interfered UE reports the information about each interfering UE to the base station through uplink signaling. The base station reallocates network resource for the interfered UE and each interfering UE, according to the report from the interfered UE, which comprises: reallocating downlink timeslots, especially for those UEs close to the base station, with the principle that we should try to allocate the UEs close to the base station and those far away from the base station in different downlink timeslots; reallocating transmitting beam to avoid the situation that each UE receives signals transmitted by the base station to different UEs with the same beam direction.

Fig.2 illustrates the method for canceling downlink far-near effect in accordance with the present invention. As it shows, at the beginning, the base station allocates UE0, UE1, UE2 and UE3 in the same downlink timeslot and the four UEs receive signals transmitted by the base station in the same beam direction. S0, S1, S2 and S3 will be transmitted by the base station respectively to UE0, UE1, UE2 and UE3, wherein UE0 is the closest to the base station, UE2 the second closest, UE3 farther, and UE1 the farthest. So, S1 will become interfering signals to UE0, UE3 and UE2, S3 will become interfering signal to UE0 and UE2, and S2 will become interfering signal to UE0.

With the method in this invention, the base station should allocate timeslots for UE0, UE1, UE2 and UE3 according to the following principle, to cancel interference caused by the far-near effect:

Allocating UE1 in a different downlink timeslot from UE0, UE2 and UE3;

Allocating UE3 in a different downlink timeslot from UE0 and UE2;

Allocating UE2 in a different downlink timeslot from UE0.

A detailed description will be given below to the DCA method for use in TDD CDMA communication system in the present invention, in conjunction with Fig.3, taking UE0 and UE2 in Fig.2 as example.

First, UE0 accesses TDD CDMA communication system and camps on a cell after powering on (step S10). When UE0 attempts to communicate with another UE through the base station, it acquires the initially allocated radio resource by the base station as normal, including: information about uplink and

downlink timeslots allocation, midamble, spreading code, beam direction in which the base station transmits signals to UE0, and etc (step S20).

When UE0 is receiving signals from the base station in downlink timeslot, it will receive signal S0 sent by the base station to it, and signals S2 sent by the base station to UE2, because UE0 and UE2 are allocated in the same downlink timeslot. Due to the far-near effect, S2 becomes the interfering signal for UE0 and UE2 becomes the interfering UE for UE0. UE0 estimates the strength of interfering signal S2 (step S30), and determines whether S2's strength exceeds a predefined value according to the estimation result (step S40). If S2's strength exceeds a predefined value, e.g. causing that S0 can't meet the QoS requirement, the interfered UE0 detects the midamble in interfering signal S2 (step S50), and reports the midamble in interfering signal S2 to the base station through uplink signaling (step S60).

After receiving the midamble in the interfering signal S2 reported by UE0, the base station finds the ID corresponding to the interfering UE2 according to the midamble, and reallocates radio resource for the interfered UE0 and/or the interfering UE2 (step S70). For instance, the base station can choose to reallocate a downlink timeslot for UE0 so that UE1 and UE2 can receive signals from the base station in different downlink timeslot. The base station can also choose to measure the relative position of UE0 and UE2, and use beams in different directions to transmit S0 and S2 to UE0 and UE2, so that S0 and S2 can be in different beams when being transmitted by the base station. Thus, UE0 and UE2 can respectively receive signals in different transmission angles from the base station, which avoids the result that UE0 will be interfered by S2. Last, the base

station notifies UE0 about the reallocated network resource, such as the reallocated downlink timeslot information, so that UE0 can receive signals from the base station in the newly allocated timeslot (step S80).

After acquiring the network resource reallocated by the base station, UE0 receives signals from the base station, by taking advantage of the reallocated network resource (step S90). For instance, UE0 can receive signals from the base station in the newly allocated downlink timeslot, or receive radio signals transmitted by the base station in a new beam direction, or receive radio signals transmitted by the base station in a new beam direction in the newly allocated downlink timeslot.

The above DCA method in TDD CDMA system as proposed by the present invention, can be implemented in computer software, or hardware modules with the same software functions in the base station or UE, or in combination of software and hardware.

Fig.4 displays the structure of the DCA apparatus in TDD CDMA communication system in accordance with the embodiment of the present invention, wherein the components same as conventional network system and UEs are not given herein.

As Fig.4 shows, UE 200 comprises: a receiving unit 204, in a downlink timeslot, for receiving signals transmitted by a network system to each UE allocated in the downlink timeslot; an estimating unit 205, for estimating the strength of each interfering signal introduced by the signals transmitted to other UEs to the signal transmitted to the UE in the received signals; a detecting unit

201, for detecting the midamble in the interfering signal if the interfering signal strength exceeds a predefined value; a transmitting unit 202, for transmitting the midamble to the network system via the uplink.

After receiving unit 101 in network system 100 receives the information about each interfering UE producing interfering signals to UE 200, allocating unit 102 allocates network resource for the interfered UE according to the information about the interfered UE, and sends the allocated network resource to the interfered UE, so that the interfered UE can use the allocated network resource to receive signals sent by the network system. The network resource can be the downlink timeslot allocated for the interfered UE by the network system, so that the interfered UE and the interfering UE can receive signals from the network system in different downlink timeslots. Furthermore, the network system can adopt other means to decrease interferences to the interfered UE, for example, determine the position information of the interfered UE and each interfering UE according to the above received information about each interfering UE through determining unit 105, and sending signals to the interfered UE and each interfering UE through transmitting unit 103, using beams in different directions, according to the position information.

Beneficial Results of the Invention

As described above, with regard to the DCA method and apparatus for use in TDD CDMA communication system as provided in the present invention, the interfered UE reports information about the interfering UE (such as the midamble in the interfering signal) to the base station, so that the base station can

reallocates radio resource for the interfered UE after obtaining the information about the interfering UE. Thus, the interfered UE can receive signals from the base station in the newly allocated downlink timeslot, which cancels the interference caused by the far-near effect.

It is to be understood by those skilled in the art that the DCA method and apparatus for use in TDD CDMA communication system as disclosed in this invention can be modified considerably without departing from the spirit and scope of the invention as defined by the appended claims.